NON-PUBLIC?: N
ACCESSION #: 8809080163
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Washington Nuclear Plant - Unit 2 PAGE: 1 of 10

DOCKET NUMBER: 05000397

TITLE: Low Reactor Pressure Vessel Level Reactor Protective System Actuation As a Result of Procedural Inadequacy
EVENT DATE: 02/13/88 LER #: 88-006-01 REPORT DATE: 09/02/88

OPERATING MODE: 3 POWER LEVEL: 000

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:
NAME: W. S. Davison, Compliance Engineer
TELEPHONE #: 509-377-2501 Ext. 2726

COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: SJ COMPONENT: LR MANUFACTURER: B040
REPORTABLE TO NPRDS: NO

SUPPLEMENTAL REPORT EXPECTED: No

ABSTRACT: Following a manual scram initiated due to high reactor coolant conductivity problems on February 13, 1988, a series of Reactor Pressure Vessel (RPV) level transients resulted in an actual low RPV Level Reactor Protective System actuation. The low level condition was initiated by loss of the only running Reactor Feedwater (RFW) Pump and was directly caused by opening the Startup Flow Control Valve while RFW System pressure was 250 psig lower than RPV pressure. This resulted in establishing a previously unrecognized diversion flowpath of reactor coolant from the Reactor Water Cleanup System backward through the Startup Flow Control Valve and to the Main Condenser Hotwell via the Long Cycle Cleanup Flow Control Valve. The root cause of the event was determined to be procedural inadequacy. Plant procedures did not give adequate guidance to the operator to ensure that the RFW System would be operated correctly during situations in which RPV pressure is higher than Reactor Feedwater System pressure.

Corrective Actions consisted of:

Modifying the RFW Speed Control System to eliminate undesirable speed ramp

characteristics, modification of operating procedures to add sufficient guidance for RFW System operations, evaluation of the need for Simulator Training, required reading of this LER, evaluation of RPV level management policy, repair of the condensate pump minimum flow control valve and evaluation of the need for feedwater system design changes. During the event all manual and automatic safety system responses occurred as designed. This event posed no threat to the safety of Plant personnel or the public.

(End of Abstract)

Plant Conditions

a) Power Level - 0%
b) Plant Mode - 3 (Hot Shutdown)

Event Description

On February 13, 1988, at 1655 hours, the reactor was manually scrammed from 35 percent reactor power due to rapidly increasing coolant conductivity. An automatic Reactor Protective System (RPS) actuation occurred 21 minutes later due to an actual low Reactor Pressure Vessel (RPV) water level condition following transients initiated by the operating Reactor Feed Pump speed controller during the process of plant shutdown. Prior to the time of the Low RPV Water Level RPS actuation, the plant was in the Hot Shutdown (Plant Mode 3) condition with RPV level and pressure being maintained using Reactor Feed Pump 1A (RFW-P-1A) and the Main Turbine Bypass Valves (BPV).

The sequence of events occurred as follows, with time zero at 1655 hours, 50 seconds:

o Time 0 minutes, 0 seconds - About 2 minutes after receiving the report from plant chemistry that hotwell conductivity was very high and the sample was cloudy, the reactor was manually scrammed at approximately 35 percent power. The rapid increase in reactor coolant conductivity to 1 micro-mho per centimeter was later determined to be due to ruptured tubes in the condenser.

o Time 0 minutes, 23 seconds - Reactor Feed Pump 1B (RFW-P-1B) was shut down as part of the reactor scram recovery action, leaving RFW-P-1A in service.

o Time 2 minutes, 9 seconds - RFW-P-1A automatic turbine speed control circuit decreased to zero demand initiating an automatic shift to speed lockup. The speed lockup feature is designed to hold the feed turbine RPM constant at its last value. Instead, pump speed began to increase

rapidly.

o Time 2 minutes, 18 seconds - RFW-P-1A turbine speed reached 3500 RPM (about 60 percent pumping capacity). At this point, RPV level was increasing at a rate of about 50 inches per minute.

o Time 2 minutes, 40 seconds - RFW-P-1A was tripped by the reactor operator as RPV level increased through +51 inches. An automatic trip would have occurred at +54.5 inches.

o Time 3 minutes, 50 seconds - The RPV level transient crested at +62 inches. At this point, the decision was made to use the RCIC system as the preferred source for maintaining RPV inventory and cooling down, thus minimizing the use of the high conductivity water in the condenser hot well as a source of makeup.

o Time 5 minutes, 20 seconds - RPV level started to decrease at about 3 inches per minute. This is considered normal level drop immediately after a plant shutdown.

o Time 6 minutes, 15 seconds - The Long Cycle Cleanup Flow Control Valve RFW-FCV-15 was opened to provide a recirculation path from the condensate system filter demineralizers back to the condenser hotwell in an effort to minimize the conductivity increase and to provide condensate pump minimum flow. Use of this valve resulted in a 70 psig lower than normal feedwater system pressure. Normally, COND-LCV-11 would have been used to supply minimum condensate flow. At this point however, COND-LCV-11 was in manual and closed.

o Time 15 minutes, 0 seconds (approximate) - Because the RCIC system suction valve to the Condensate Storage Tank's (CSTs) was closed, deenergized and caution tagged, the only RCIC suction source was the Pressure Suppression Pool. Since depressurization using RCIC would mean discharging suppression pool water to CSTs, the decision was made to realign the RCIC suction to the Condensate Storage Tanks prior to starting the RCIC pump.

o Time 15 minutes, 30 seconds (approximate) - The decision was made to start using the condenser hotwell as the RPV water source until the RCIC suction could be realigned.

o Time 15 minutes, 54 seconds - Startup Flow Control Valve RFW-V-10A was manually opened in preparation for using the condensate booster pumps to supply feedwater to the RPV when pressure decreased to within the

capability of the pumps. RPV level had dropped into the normal level control range of +35 inches at this point. RPV level immediately began to decrease at approximately 20 inches per minute. (See Figure 1 for Condensate and Reactor Feedwater System lineup). The operators were not aware that the reason for the rapid RPV inventory loss rate was backflow of RWCU water through RFW-V-10A and into the condenser via the RFW System Long Cycle Cleanup Valve RFW-FCV-15.

o Time 16 minutes, 9 seconds - The RPV Low Level alarm was received as level decreased through +31.5 inches.

o Time 16 minutes, 55 seconds - The DEH panel operator initiated a 200 psig per minute depressurization ramp with a pressure setpoint of 600 psig. Since the existing setpoint for the DEH pressure controller was 940 psig and reactor pressure was 840 psig, no BPV movement occurred.

o Time 17 minutes, 45 seconds - When RPV level decreased to +18 inches, the Reactor Core Isolation Cooling (RCIC) System was started to provide a source of high pressure feedwater to the RPV by injection via the RCIC head spray nozzle.

o Time 17 minutes, 55 seconds - The DEH pressure setpoint decrease ramp reached 840 psig, matching reactor pressure. As the setpoint decreased below reactor pressure, the Main Turbine Bypass Valves automatically positioned to 50 percent open, causing a rapid increase in depressurization rate, which resulted in a rapid RPV level swell transient.

o Time 18 minutes, 10 seconds to 18 minutes, 27 seconds - RCIC injection and the level swell transient combined to increase RPV level to the RCIC High RPV Level auto trip setpoint of +54.5 inches, causing an automatic shutdown of the RCIC System. The level increase transient crested at +57.5 inches. RPV level then started to decrease rapidly as a result of BPV oscillations caused by the initial pressure control system reaction to regulate the depressurization rate.

o Time 20 minutes, 45 seconds - As RPV level decreased through +19 inches, the RCIC System was restarted to supply high pressure water to the RPV.

o Time 21 minutes, 0 seconds - The DEH panel operator changed the depressurization rate to 25 psig per minute as RPV pressure reached approximately 625 psig. RPS automatically actuated when RPV Level reached the +13 inch Low RPV Level RPS actuation setpoint.

o Time 21 minutes, 0 seconds to 21 minutes, 20 seconds - As a result of the pressure ramp rate change, the BPVs repositioned in the Close direction from 50 percent Open to 15 percent Open. As the BPVs closed down, the decrease in the depressurization rate caused RPV level to shrink at a rate greater than the RCIC System could increase RPV level. RPV level started to decrease rapidly.

o Time 21 minutes, 30 seconds - The RPV level decrease leveled off at 0 inches as the level shrink transient dampened.

o Time 21 minutes, 40 seconds - The DEH panel operator changed the pressure setpoint to 550 psig at a rate of 200 psig per minute. This caused the BPVs to begin to open rapidly. RPV level again started to increase rapidly due to the combined effects of level swell and RCIC injection.

o Time 21 minutes, 45 seconds - The BPVs reached 100 percent Open position.

o Time 21 minutes, 50 seconds - RPV level increased to +54.5 inches and caused the RCIC System to automatically shut down due to again reaching the RCIC High RPV Level automatic trip setpoint.

o Time 21 minutes, 55 seconds - As RPV pressure reached 550 psig, the DEH pressure control system responded by rapidly closing the BPVs. This initiated a level shrink transient which caused RPV level to decrease rapidly.

o Time 22 minutes, 10 seconds - The RCIC System was restarted to supply high pressure water to the RPV. RPV pressure dropped below the discharge pressure of the condensate booster pump, allowing the RFW system to begin to supply water to the RPV.

o Time 24 minutes, 10 seconds - The RPV level decrease transient was arrested at -4 inches due to the combination of RCIC injection and condensate booster pump supply.

o Time 24 minutes, 30 seconds - RPV level increased to above +13 inches, the RPS Low RPV Level actuation setpoint.

o Time 25 minutes, 20 seconds - RPV level reached the normal operating level of +36 inches. Event end.

Further Evaluation and Corrective Action

Further Evaluation

1. This incident is being reported as an event which resulted in the automatic actuation of an Engineered Safety Feature per the requirements of 10CFR50.13(a)(2)(iv).

2. The reportable occurrence was an automatic RPS actuation due to an actual low RPV level at 1716 hours on February 13, 1988. The low RPV level event was a result of transients initiated during the follow-up action for the manual scram initiated at 1655 hours.

3. The immediate cause of the low RPV level RPS actuation was determined to be the opening of the Startup Flow Control Valve RFW-FCV-10A while RPV pressure was 250 psig greater than Reactor Feedwater System pressure. Because the Long Cycle Cleanup Valve RFW-FCV-15 had been previously opened to the condenser hotwell, opening RFW-FCV-10A resulted in a rapid diversion of water inventory from the RPV through the RWCU System backwards through RFW-FCV-10A to the condenser via RFW-FCV-15. The cause of this loss was unknown during the event.

4. The root cause of the low RPV level RPS actuation was determined to be procedural deficiency. The Reactor Scram Recovery Procedure did not contain adequate information to properly direct operation of the Reactor Feedwater System during conditions in which RPV pressure is greater than Reactor Feedwater System pressure. This allowed the Startup Flow Control Valve to be opened to inadvertently establish an unrecognized diversion path of reactor coolant from the RPV via RWCU to the condenser hotwell. This diversion flow path was the primary cause for RPV level dropping from +35 inches to the +13 inch RPS actuation setpoint.

5. The following were evaluated as contributing factors to the event:

o The condensate pump recirculation control valve COND-LCV-11 was inoperable due to high piping vibration experienced during previous use. This valve controls the preferred flowpath of condensate through the condensate filter demineralizers and back to the condenser hotwell when clean up of the feedwater system is desired. Inability to use this cleanup flow path necessitated the use of RFW-FCV-15, the Long Cycle Cleanup Flow Control Valve. During the event, the use of RFW-FCV-15 provided an unexpected diversion flowpath of water from the RPV via the RWCU System to the condenser hotwell. Normally RWCU flow would return to the RPV via the feedwater inlet piping.

o During a previous plant refueling and maintenance outage, a design

modification to the Reactor Feedwater Pump speed control circuitry was installed to maintain RPV level during a loss of feedwater drive turbine control signal.

The design added a speed lockup feature which would lock in the speed of the Reactor Feedwater Pump during loss of power/loss of signal conditions. This design however, did not accomplish that objective. As a combined result of calibration inaccuracies, minor system oscillations and insufficient governor control deadband, the governor unit functioned to either increase or decrease turbine speed as a result of minor differences between governor input signal and the lockup signal developed by the feedwater pump control tachometer. Instead of a speed lock-up for the pump, the circuit functioned during the event to insert a speed increase ramp resulting in a 1700 rpm increase in approximately 9 seconds. This pump speed increase resulted in overfeeding of the RPV and manual trip of the Reactor Feed Pump. The loss of the Reactor Feed Pump resulted in the RPV pressure being greater than Reactor Feedwater System pressure by approximately 250 psig. This unusual pressure differential established the driving head required for flow of RPV water inventory from RWCU through the Startup Flow Control Valve in the reverse direction and to the condenser hotwell via RFW-FCV-15.

o The operation of the BPV's during the event was not coordinated well with the attempt to feed the RPV using the RCIC system. The rapid RPV level increases resulting in the automatic shutdown of the RCIC System were brought about by the effort to expeditiously depressurize the RPV to less than 600 psig in order to use the condensate booster pumps to supply feedwater to the RPV. The depressurization rate initially used and subsequent changes to the rate resulted in rapid BPV movement which caused rapid RPV level shrink and swell transients. The inability to continuously feed the RPV using the RCIC System contributed significantly to the existing level inventory control problem.

6. The following factors contributed to the failure of the operators to either recognize the cause of the RPV water inventory loss or understand the severity of the level transient during the course of the event:

o The combined effects of the overspeeding of RFW-P-1A causing a large RPV level increase and rapid turbine bypass valve movement resulted in a series of RPV level transients. The particular transient associated with opening RFW-V-10A causing a 20 inch per minute level decrease only lasted 15 to 20 seconds after which the decrease rate settled out at 7 inches per minute. Associating a change in the

rate of level decrease with the action of opening RFW-V-10A was difficult at best due to the masking effect of these ongoing level transients.

o Until the BPV movement ceased and the RPV level transients normalized, about eight minutes after RFW-V-10A was opened, the extent of the water inventory loss was not able to be seen as a stable low RPV level indication.

o The plant condition set up by the loss of operating RFW pumps in which the Feedwater System pressure was 250 psig less than RPV pressure with the condensate pump recirculation control valve out of service was unusual. Plant operators did not have experience maneuvering the plant during this condition.

7. During the initial high RPV level transient resulting in a level of +62 inches at Time 3 minutes, 50 seconds, the ink pen for the Narrow Range RPV Level Recorder (RFW-LR-608) located on the Reactor Control Console vertical section, stuck at the high limit and stayed there during the remainder of the event.

8. All automatic actions which should have been initiated at RPV Level 3 (+13 inches) did occur as designed. The only actual operation of components that occurred were logic relay actuation and repositioning of valves for the reactor scram function of the Control Rod Drive (CRD) System. No control rods were actually repositioned since they had been previously inserted fully into the core. Other automatic functions which occurred are:

o Reactor Recirculation Pumps received a signal to automatically shift to slow speed (15 hertz) operation. This shift did not occur because both pumps were being operated at 15 hertz at the time of the event.

o Nuclear Steam Supply Shutoff System (NS4) Groups 5 and 6 received an isolation signal. No valves or components changed status because they were in the isolation position at the time of the event.

o An Automatic Depressurization System (ADS) Low RPV Level 3 Confirmation Signal was generated. This is one of two control logic RPV level functions required for the ADS initiation of seven Safety Relief Valves.

Corrective Action

1. The Reactor Feedwater Pump Speed Control System has been modified to eliminate the undesirable speed ramp characteristic.

2. Narrow Range RPV Level Recorder RFW-LR-608 has been overhauled, tested and reinstalled in the Reactor Control Console. This recorder is a Model No. 732, manufactured by Bailey Instrument Company, GE MPL Number C34-R608. WNP-2 is currently pursuing replacement of this type of recorder with a more reliable type.

3. Operating procedures have been modified to include additional information concerning both control of RPV level during shutdown conditions with RPV pressure greater than feedwater system pressure and use of BPV's to control depressurization rates.

4. A study will be conducted to evaluate the need to add this scenario to the Simulator Training Program.

5. This LER will be required reading for all licensed operators and will be added to the subject matter list for requalification training.

6. An evaluation will be conducted by the Operations Manager to determine the requirement for increased policy guidance concerning methods for improved early management of RPV level control options following a reactor scram.

7. The condensate pump minimum flow valve COND-LCV-11 will be modified during the upcoming 1988 refueling and maintenance outage to rectify the previously experienced vibration problems.

8. A technical evaluation will be performed to determine the necessity for design changes to the Feedwater System to preclude recurrence of this event.

Safety Significance

All manual and automatic safety system responses occurred as designed. The Reactor Protective System functioned correctly to respond to the manually initiated reactor scram and to cause an automatic actuation in response to an actual reactor vessel low level (Level 3) condition. The faulty RPV narrow range level recorder reading was compensated for by valid readings on the vertical section of the reactor control console from three narrow range RPV level indicators. With the reactor shut down, the significant safety concern is potential uncovering of the fuel. The top of active fuel is located at

-161 inches vessel level. Since the level transient was terminated at -4 inches, more than adequate vessel water inventory remained to assure fuel coverage. This event posed no threat to the safety of Plant personnel or the public.

Similar Events

LER 88-001 reported a previous low RPV level RPS actuation which occurred shortly after a plant shutdown.

EIIS Information

Text Reference EIIS Reference

System Component

RPS JC - - -
RPV SB RPV

EIIS Information

Text Reference EIIS Reference

System Component

Reactor Feed Pump 1A SJ P
Reactor Feed Pump 1B SJ P
Reactor Feed Pump Speed Controller JB SC
Main Turbine Bypass Valves SO V
Feed Turbine SJ TRB
RCIC BN - - -
RFW-FCV-15 SJ FCV
Reactor Feed Water System SJ - - -
RFW-V-10A SJ V
DEH SB - - -
Condensate Storage Tank KA T
COND-LCV-11 SD LCV
RFW-LR-608 SJ LR
Reactor Recirculation Pumps AD P
NS4 JM - - -
ADS SB - - -
CRD AA - - -
RWCU CE - - -
Safety Relief Valve SB RV

FIGURE 1
CONDENSATE AND FEEDWATER FLOWPATH

FIGURE OMITTED - NOT KEYABLE (DIAGRAM)

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
P.O. Box 968 . 3000 George Washington Way . Richland, Washington 99352

Docket No. 50-397

September 2, 1988

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: NUCLEAR PLANT NO. 2
LICENSEE EVENT REPORT NO. 88-06-01

Dear Sir:

Transmitted herewith is Licensee Event Report No. 88-06-01 for the WNP-2 Plant. This report is submitted in response to the report requirements of 10CFR50.73 and discusses the items of reportability, corrective action taken, and action taken to preclude recurrence.

Very truly yours,
/s/ J. W. Baker
C. M. Powers (M/D 927M)
WNP-2 Plant Manager

CMP:sm
Enclosure:
Licensee Event Report No. 88-06-01

cc: Mr. John B. Martin, NRC - Region V
Mr. C. J. Bosted, NRC Site (M/D 901A)
INPO Records Center - Atlanta, GA
Ms. Dottie Sherman, ANI
Mr. D. L. Williams, BPA (M/D 399)

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